Final Report

Title: Monitoring Living Shorelines at Hull Springs Farm
Author: Mark L. Fink
Date: February 15, 2010
Grant Number: NA07NOS4190178
Task Number: 2.04

Acknowledgments:

This project was funded, in part, by the **Virginia Coastal Zone Management Program** at the Department of Environmental Quality through Grant #NA07NOS4190178 of the U.S. Department of Commerce, **National Oceanic and Atmospheric Administration**, under the Coastal Zone Management Act of 1972, as amended.

The views expressed herein are those of the authors and do not necessarily reflect the views of the U.S. Department of Commerce, NOAA, or any of its subagencies.

Additional funding was provided by the **Longwood University Faculty Research Grant program** and by the **Hull Springs Farm Foundation**.

Virginia Coastal Zone
MANAGEMENT PROGRAM

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

LONGWOOD
UNIVERSITY

HULL SPRINGS FARM
OF LONGWOOD UNIVERSITY
EDUCATING • CONSERVING • SUSTAINING

Background

This project seeks to assess the biological productivity of the sill and fringe marsh installation at Hull Springs Farm (HSF), a 258-ha site in Westmoreland County, Virginia. HSF has 2560 m of shoreline on two tidal creeks (Aimes and Glebe) of the Lower Machodoc Creek tributary of the Potomac River. Much of this shoreline is subject to extensive erosion, and in 2006 HSF began a shoreline protection plan that resulted in the establishment of an award-winning sill and fringe marsh in 2008. The sill is a 130-m low wall of rocks running parallel to the shoreline to absorb wave energy. A tidal fringe marsh was created by placing sand and stone between the sill and bank and planting it with marsh grasses (*Spartina alterniflora* and *S. patens*). The sill incorporates two types of breaks to permit movement of animals during changing tides (Hull Springs Farm Natural Resource Advisory Council 2009).

These "living shoreline" techniques of erosion control are purported to preserve the shoreline while restoring habitat that supports shorebirds, juvenile fish, tidal marsh, submerged aquatic vegetation, and other plant and wildlife species. Living shoreline techniques may offer a biologically sensitive alternative to bulkheads and other "shore hardening" structures, which are expensive, temporary and damaging to shoreline habitat (Seitz et al. 2006). However, there is a critical need for research on the impacts that living shoreline techniques have on the diversity and abundance of shoreline communities. This report contains the preliminary results of the on-going, long-term assessment and monitoring project of the biological productivity of the sill and fringe marsh structures established at HSF. The hypothesis being tested is that the created marsh and sill habitat will have equal or greater productivity than existing conditions, i.e., the living shoreline project will have a net positive aquatic resource benefit.

Methods

The biological diversity of the HSF shoreline was sampled prior to and following the establishment of the sill and fringe marsh living shoreline structures in June of 2007 and 2009, respectively. Similar methodologies were followed each year to allow comparisons. Thirty 9-m transects were spaced at random intervals and perpendicular to the shoreline. The 0-m point of each transect marked the mid-tide line. Nekton (free-swimming fishes and other aquatic organisms) were sampled using a 1-m^2 throw trap at 3 and 9 m along each transect (60 total samples per year) as well as a 30-m seine drawn at 9 locations along the length of the shoreline (9 total samples per year). Along each transect at 0, 3, and 9 m, benthic invertebrates were sampled by taking 13,000 cm^3 sediment cores (90 cores total per year) and sieving samples for invertebrates.

Product #1

Throughout the fall of 2009, five Longwood University undergraduate students under the direction of Mark Fink, PhD, analyzed the samples collected in June of 2007 and 2009 at HSF. In total, the analysis consisted of 120 throw-trap samples, 27 seine bucket samples, and 180 sediment core samples.

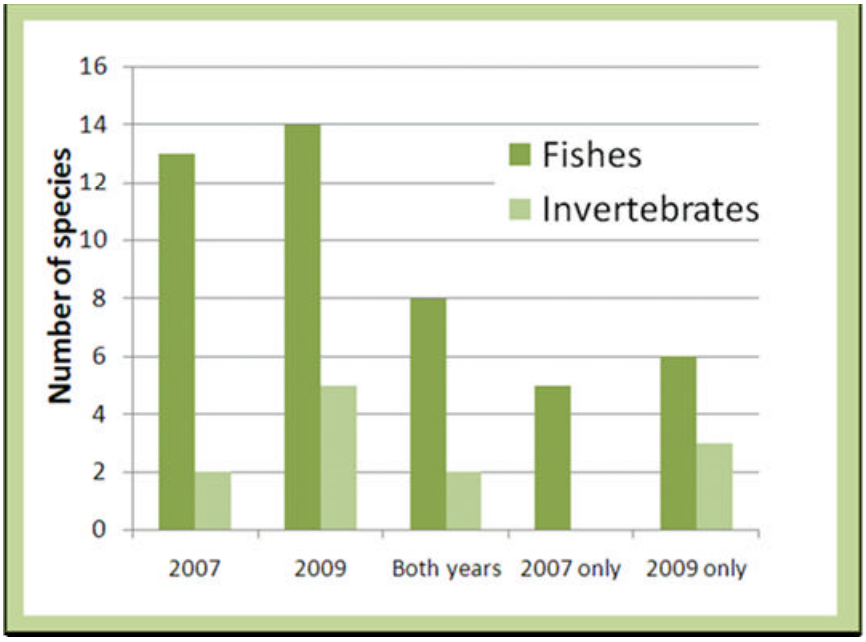
For this analysis, nekton samples from throw-trapping and seining were pooled. All organisms were identified to species and enumerated (Table 1).

Table 1. Total nekton counts from throw-trapping and seining trials for 2007 and 2009.

Bony Fishes	**Scientific Name**	**2007**	**2009**
Alewife	*Alosa pseudoharengus*	1	0
American Shad	*Alosa sapidissima*	0	685
Atlantic Needlefish	*Strongylura marina*	0	2
Banded Killifish	*Fundulus diaphanous*	113	444
Bay Anchovy	*Anchoa mitchilli*	193	45
Bluefish	*Pomatomus saltatrix*	0	1
Carp	*Cyprinus carpio*	0	1
Chain Pipefish	*Syngnathus louisianae*	0	1
Gizzard Shad	*Dorosoma cepedianum*	2	0
Hogchoker	*Trinectes maculatus*	1	0
Inland Silverside	*Menidia beryllina*	1882	843
Marsh Killifish	*Fundulus confluentus*	0	3
Mummichog	*Fundulus heteroclitis*	5	0
Naked Goby	*Gobiosoma bosc*	5	1
Sheepshead Minnow	*Cyprinodon variegatus*	1	1
Spot	*Leiostomus xanthurus*	5	4
Striped Bass	*Morone saxatilis*	13	0
Striped Killifish	*Fundulus majalis*	185	9
White Perch	*Morone americana*	16	10
Invertebrates	**Scientific Name**	**2007**	**2009**
Blue Crab	*Callinectes sapidus*	8	15
Lady Crab	*Ovalipes ocellatus*	0	2
Grass Shrimp	*Hippolyte sp.*	1002	797
Greedy Isopod	*Cirolana sp.*	0	1
Softshell Clam	*Mya arenaria*	0	1

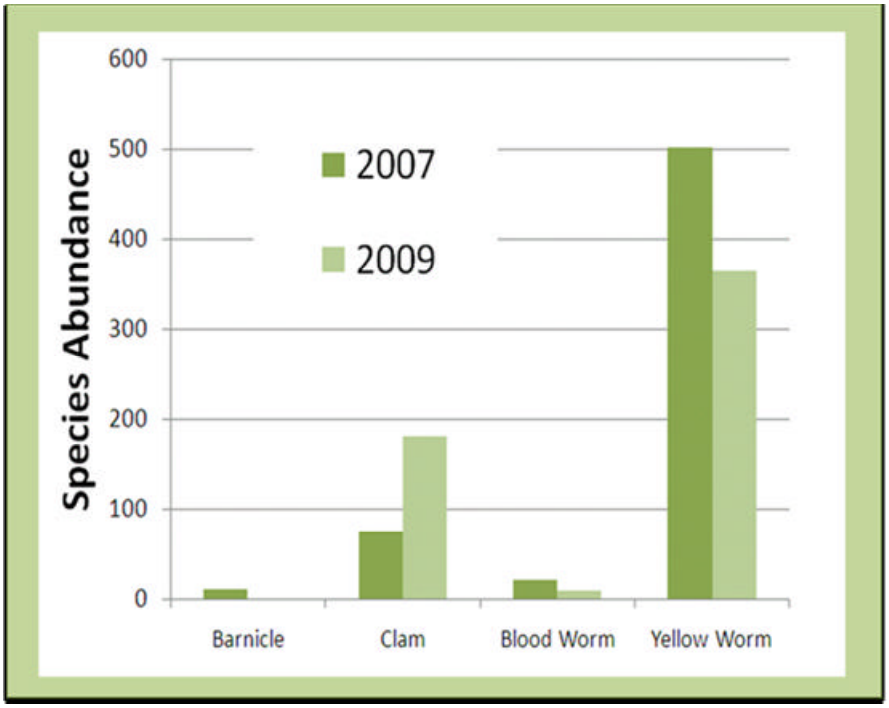
Diversity and abundances of nekton differed between years of the study (i.e., prior to and following living shoreline establishment, Fig. 1). Fifteen species of bony fishes and two species of invertebrates were detected in 2007 nekton samples compared to 14 species of bony fishes and 5 species of invertebrates detected in 2009 nekton samples. Only 8 of 19 species of bony fishes were common to both years of the study. Five species were detected only in 2007; six were detected only in 2009 (Fig. 1). While not detected at all in 2007, American shad (*Alosa sapidissima*) were abundant in 2009. Conversely, striped killifish (*Fundulus majalis*) were notably more abundant in 2007. The overall nekton diversity estimate, as measured using the Shannon-Weiner diversity index ($H = - S (P_i * \ln(P_i))$) which considers both species richness and abundance, suggest nekton biodiversity was greater in 2009 ($H = 1.523$) than in 2007 ($H = 1.221$).

Figure 1. Summary of nekton samples from throw-trapping and seining trials for 2007 and 2009.



However, preliminary analysis of benthic invertebrates (Fig. 2) suggests less overall biodiversity in 2009 than in 2007. Also, the majority of 2009 invertebrates were located at the 9 m sampling point outside the sill. Compaction of the sand used to construct the marsh may slow colonization of the marsh by invertebrates. Analysis of species composition for the benthic invertebrate samples is still ongoing.

Figure 2. Benthic invertebrates recovered from core samples by year.



While preliminary analysis suggests overall greater biodiversity of benthic invertebrates prior to the establishment of the living shoreline, change in species composition appears evident. The lower biodiversity indicators in 2009 are likely due to the disturbance caused by sill and marsh construction in 2008; researchers predict continuing change and overall increase in biodiversity as the new fringe marsh matures.

Product #2

During three days in December 2009, five Longwood University undergraduates under the direction of Dr. Mark Fink, collected additional samples at HSF using the same protocols established for previous data collection. Data collected included water quality parameters, water column sampling (throw-trapping and seining) and sediment core sampling for benthic invertebrates. This was the first collection of data during cold weather. Winter samples are currently being processed in the lab.

Future directions

Further analyses of data will continue in spring of 2010. Additional components of biodiversity measured in 2007 and 2009 (abundance and diversity of plants and terrestrial invertebrates) will be analyzed. Also, possible covariates of biodiversity (sediment samples, water quality measures) will be examined. Although data on the effects of living shorelines are scarce, research suggests the importance of long-term monitoring of aquatic communities to evaluate human-induced changes in estuarine biodiversity (Raposa et al. 2003). As such, researchers will

continue to monitor changes in the living shoreline community as it matures; repeated warm-season and cold-season sampling will take place through 2015.

Executive Summary

Background
This project seeks to assess the biological productivity of the sill and fringe marsh installation at Hull Springs Farm (HSF). The hypothesis being tested is that the created marsh and sill habitat will have equal or greater productivity than existing conditions, i.e. the living shoreline project will have a net positive aquatic resource benefit.

Product #1
Throughout the fall of 2009, five Longwood University undergraduate students under the direction of Mark Fink, PhD, analyzed the samples collected in June of 2007 and 2009 at HSF. In total, the analysis consisted of 120 throw-trap samples, 27 seine bucket samples, and 180 sediment core samples. Diversity and abundances of nekton differed between years of the study (i.e., prior to and following living shoreline establishment). Fifteen species of bony fishes and two species of invertebrates were detected in 2007 nekton samples compared to 14 species of bony fishes and 5 species of invertebrates detected in 2009 nekton samples. Using a Shannon-Weiner diversity index, overall nekton biodiversity was greater in 2009 (1.523) than in 2007 (1.221). Conversely, preliminary analysis of the benthic invertebrate community suggests lower biodiversity following the establishment of the sill and fringe marsh. Compaction of the sand used to construct the marsh may slow colonization by invertebrates. This basic inventory of the biological communities both before and after the installation of the sill and marsh will aid in assessment of the potential productivity value of the living shoreline; continuing community changes and an overall increase in biodiversity is predicted as the new fringe marsh matures. Monitoring is scheduled to continue through 2015.

Distributing the results: Students presented a research poster *("Just another day at the sill: Assessing effects of 'living shoreline' techniques on aquatic communities at Longwood's Hull Springs Farm")* at the annual Cook-Cole College of Arts & Sciences Undergraduate Research Showcase held on November 20 on the Longwood University campus. Dr. Fink has presented summaries of the research project and preliminary data with the Longwood University Board of Trustees, the Longwood University Foundation Board, and the Hull Springs Farm Board of Directors. Future presentations are planned, including the Center for Coastal Resources Management (CCRM) at Virginia Institute of Marine Science (VIMS) Tidal Wetlands Workshop in fall of 2010 or spring 2011 for members of citizen Wetlands Boards. Dr. Fink intends to pursue publishing an article about this research in a peer-reviewed journal. Until then, a summary of results will be put on the Hull Springs Farm web site: http://www.longwood.edu/hullspringsfarm/

Product #2
Under the direction of Dr. Mark Fink, five undergraduate students collected additional samples in December 2009 at HSF using the same protocols established for previous data collection. This was the first collection of data during cold weather. Winter samples are currently being processed in the lab.

Literature cited

Hull Springs Farm Natural Resource Advisory Council. Briefing document. 2009. Hull Springs Farm of Longwood University.

Raposa, K.B., C.T. Roman, and J.F. Heltshe. 2003. Monitoring nekton as a bioindicator in shallow estuarine habitats. Environmental Monitoring and Assessment 81: 239-255.

Seitz, R.D., R.N. Lipcius, N.H. Olmstead, M.S. Seebo, and D.M. Lambert. 2006. Influence of shallow-water habitats and shoreline development on abundance, biomass, and diversity of benthic prey and predators in Chesapeake Bay. Marine Ecology Progress Series 326: 11-27.

Final Report -- Photos

Title: Monitoring Living Shorelines at Hull Springs Farm
Author: Mark L. Fink
Date: February 15, 2010
Grant Number: NA09NOS4190163 OR NA07NOS4190178
Task Number: 2.04

Photos taken during the sample collection (June 2009) and the laboratory analysis of the samples (Fall 2009). If the Virginia CZM or NOAA would like electronic files of these photos, please contact Katie Register, Hull Springs Farm's Project Director, 434-395-2602 or registerkm@longwood.edu.